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FOREST PEST MANAGEMENT

3430 BIOLOGICAL EVALUATION
R2-84-5

Western Spruce Budworm
in the
Rocky Mountain Region

United States
Department of
Agriculture

Forest Service

Forest Pest Management
Denver, Colorado

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ABSTRACT

In 1984, results of aerial surveys showed that approximately 2,000,000 acres of forest were infested in Colorado and 133,000 acres were infested in Wyoming. Defoliation intensity was moderate to severe throughout most of Colorado and light to moderate in Wyoming.

For the 1984 budworm egg mass survey, 1440 branch samples were collected from 46 sites throughout the outbreak area. In Colorado, survey results indicate that egg mass densities have increased from 1983 levels and moderate to severe defoliation is expected throughout most of the outbreak area in 1985. In Wyoming, egg mass densities indicate that light defoliation is expected next summer.

Forest Supervisors and other land managers should pay particular attention to developed recreation areas where treatment may be warranted.

INTRODUCTION

Outbreaks of the western spruce budworm have occurred along the Colorado Front Range from 1935 to 1945 and from 1957 to 1962. The current outbreak appears to have begun in the northern Colorado Front Range around 1974.

The population dynamics of the budworm are not fully understood. It is believed that harvesting methods, along with the effective prevention and control of fires since the 1920's resulted in the development of dense stands with a higher percentage of shade-tolerant, climax tree species favorable to the budworm.

Natural biological factors such as parasites and pathogens generally do not appear to be important in regulating increasing western spruce budworm populations. However, a population collapse on the Rampart Range in Colorado in 1963 was associated with a significant increase in the parasite Bracon pelliventris (Cushman) (McKnight, 1967).

Unfavorable weather, particularly late spring frosts, has had the most dramatic effect on budworm populations in the West (Klein 1967, Fellin et al. 1972, McKnight 1971). Collapse of budworm outbreaks along the northern Front Range of Colorado in 1945 and on the Shoshone National Forest in 1936 followed late spring frosts which decimated the budworm populations (McKnight 1967, Lister 1969).

Forest Pest Management monitors the western spruce budworm through annual aerial detection and egg mass surveys. Annual surveys are conducted to provide concerned land managers with information about extent, intensity and predictions of budworm population trends within the Region.

TECHNICAL INFORMATION

Insect: Western spruce budworm, Choristoneura occidentalis Freeman

Hosts: Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco
White fir, Abies concolor (Gord. & Glend.) Lindl.
Subalpine fir, Abies lasiocarpa (Hook.) Nutt.
Blue spruce, Picea pungens Engelm.
Engelmann spruce, Picea engelmannii Parry

Life History: The western spruce budworm completes one generation each year.

Stage	Time	Location on host
Egg	August	On needles
Small larvae	Overwinter	In hibernaculum (silken cocoons) on branches and trunk
Larger larvae	June	On buds, strobile, and foliage
Pupae	July	On foliage
Adults	August	In flight

Evidence of Infestation

1. Presence of partially eaten foliage.

2. Mature larvae feeding on current year's needles.

3. Current year's shoots webbed together by larvae.

4. Defoliation most evident in upper crowns of trees.

5. Trees dying from the top downward after several years of heavy defoliation.

EXTENT OF THE OUTBREAK

In 1984, aerial surveys indicated approximately 2.13 million acres were infested in the Rocky Mountain Region (Figure 1). Budworm infested acreage in the Region is displayed in Table 1.

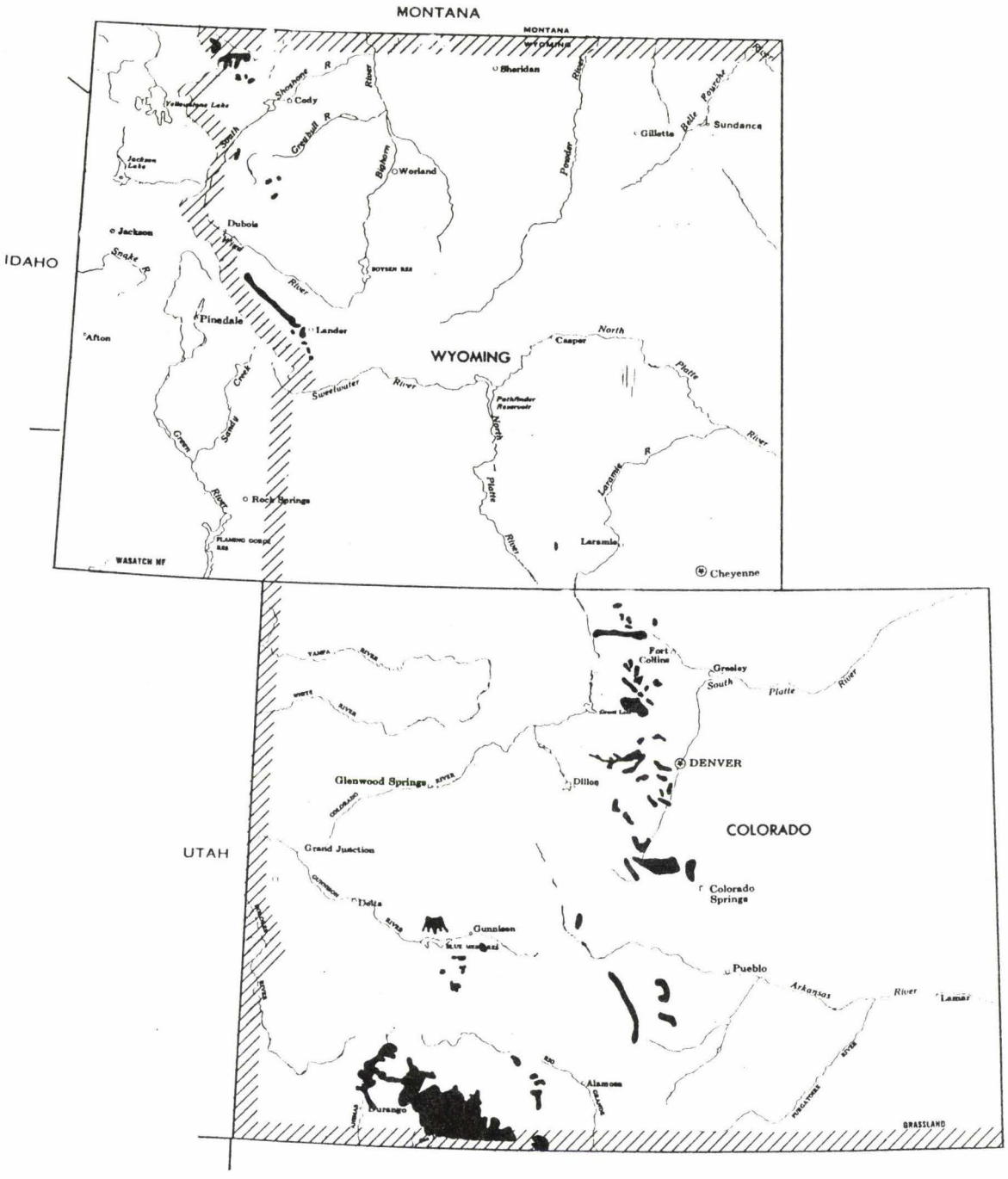

Figure 1. Occurrence of visible western spruce budworm defoliation in the Rocky Mountain Region.

Table 1. 1984 Western Spruce Budworm Infestation Acreage by Land Ownership Class.[1/]

Area	Land Ownership Class				
	National Forest	Other Federal	State	Private	Total
Arapaho	21,360	3,137	1,355	42,339	68,191
Gunnison	49,915	15,707	362	4,141	70,125
Medicine Bow	332	0	0	42	374
Pike	135,879	3,010	3,862	131,599	274,350
Rio Grande	56,902	2,515	339	4,361	64,117
Roosevelt	68,002	4,762	969	36,717	110,450
San Isabel	114,640	11,185	0	85,821	241,646
San Juan	780,864	131,583	11,265	306,944	1,230,656
Shoshone	31,400	84,700	0	16,900	133,000
White River	315	0	0	0	315
Total	1,289,609	256,599	18,152	628,864	2,193,224

1/ Acreage infested by budworm was determined from aerial sketch maps made at the time of peak foliar damage.

The current outbreak began along the northern Front Range of Colorado in 1974. Since then, the area infested by the insect has expanded to the Southern Front Range and the southwestern portion of the state. In 1984, the budworm infested more than 2.1 million acres in Colorado. The budworm now infests almost all of the Douglas-fir and white fir types in the State and is expanding further into the mixed conifer areas. Most of the top-kill and total tree mortality caused by this insect occurs along the northern Front Range where defoliation has occurred each year for the last 10 years.

In Wyoming, the area infested by the budworm was 133,000 acres - the same as it was in 1983.

EVALUATION METHODS

Egg mass density is used to monitor and predict spruce budworm population trends, evaluate long term effects of control projects and to forecast defoliation. Annual defoliation predictions are based on the density of new egg masses on branch samples collected from the midcrown of host trees (Carolin and Coulter, 1959, 1972).

Egg mass density and defoliation surveys were made during August and September after the egg deposition period. This year, 1440 branch samples were collected from 240 plots at 46 sites throughout the outbreak area. The locations of these sites are listed in Table 2.

Table 2. Locations of 1984 Egg Mass Sampling Plots.

Area	Plot Name	Location
Arapaho	Idaho Springs	T. 4 S., R. 73 W., Sec. 10, 11
	Sprucedale	T. 5 S., R. 71 W., Sec. 20
Gunnison	Amphitheater C.G.	T. 44 N., R. 7 W., Sec. 32
	Commissary C.G.	T. 50 N., R. 2 W., Sec. 19
	Powderhorn	T. 46 N., R. 3 W., Sec. 1
	Sapinero Mesa	T. 47 N., R. 3 W., Sec. 23
	Soap Creek	T. 50 N., R. 4 W., Sec. 32
Pike	Current Creek	T. 15 S., R. 73 W., Sec. 15
	Indian Creek	T. 8 S., R. 69 W., Sec. 10, 14
		T. 8 S., R. 70 W., Sec. 19
	Little Scraggy	T. 8 S., R. 71 W., Sec. 24
	Ormes Peak	T. 13 S., R. 68 W., Sec. 1, 2
Rio Grande	Beaver Creek	T. 38 N., R. 3 E., Sec. 11
	Del Norte Peak	T. 39 N., R. 4 E., Sec. 8
	Embargo Creek	T. 41 N., R. 4 E., Sec. 19
Roosevelt	Big Elk Meadows	T. 3 N., R. 72 W., Sec. 1, 11
		T. 4 N., R. 72 W., Sec. 36
	Devil's Gulch	T. 5 N., R. 72 W., Sec. 4
	Magnolia Road	T. 1 S., R. 71 W., Sec. 5, 8
San Isabel	Alvarado C.G.	T. 23 S., R. 73 W., Sec. 5
	Balman Reservoir	T. 46 N., R. 12 E., Sec. 6
	Beulah	T. 23 S., R. 68 W., Sec. 28, 29
	Music Pass	T. 23 S., R. 72 W., Sec. 32
	Oak Creek C.G.	T. 20 S., R. 70 W., Sec. 19
	Ophir C.G.	T. 23 S., R. 69 W., Sec. 9
San Juan	Blanco Basin	T. 35 N., R. 2 E., Sec. 30
	Cimarrona C.G.	T. 38 N., R. 3 W., Sec. 8
	Columbine Lake	T. 39 N., R. 8 W., Sec. 31
	Coon Creek	T. 37 N., R. 8 W., Sec. 33
	East Fork	T. 36 N., R. 1 E., Sec. 7
	Halfway Canyon	T. 33 N., R. 1 W., Sec. 3
	Haviland Lake	T. 38 N., R. 9 W., Sec. 25
	Little San Creek	T. 38 N., R. 4 W., Sec. 27
	Missionary Ridge	T. 37 N., R. 8 W., Sec. 34
	Old Timers C. G.	T. 36 N., R. 6 W., Sec. 20
	Pine River C. G.	T. 37 N., R. 6 W., Sec. 26
	Poison Park	T. 38 N., R. 3 W., Sec. 15
	Transfer Park C. G.	T. 37 N., R. 7 W., Sec. 19
	Vallecito Reservoir	T. 37 N., R. 6 W., Sec. 16
		T. 36 N., R. 6 W., Sec. 8
	Wolf Creek C. G.	T. 37 N., R. 1 E., Sec. 16

Table 1 (continued)

Shoshone	Badger Spring	T. 56 N., R. 105 W., Sec. 24
	Dead Indian	T. 55 N., R. 104 W., Sec. 16
	Hunter Peak C. G.	T. 57 N., R. 106 W., Sec. 21
	Reef Creek	T. 56 N., R. 105 W., Sec. 5
	Rocky Ford	T. 56 N., R. 106 W., Sec. 1, 11 & 14
	Sinks Canyon	T. 32 N., R. 101 W., Sec. 24, 28

Each plot consisted of six dominant or co-dominant host trees within close proximity. Only trees of one species were sampled at each plot. One 27-inch branch was pruned from the midcrown of each tree for a total of six branches per plot. The foliage samples were bagged, labeled, and transported to the laboratory, where new egg mass densities were determined. A microscope was used to separate new from old egg masses.

Egg mass density classes and associated defoliation are displayed in Table 3. These classes are adopted from McKnight et al. (1970) and were refined by Linnane (1978) based on four years of data from the fixed plot, cluster tree, sampling scheme.

Table 3. Defoliation prediction classes for western spruce budworm egg mass sampling in Region 2.

Class	Mean Number of New Egg Masses Per Square Meter Foliage	Defoliation Prediction 1/
1	1.6 or less	Undetectable
2	1.7 to 10.0	Light
3	10.1 or more	Moderate to Severe

1/

Defoliation expected on new growth only

Undetectable	0 - 10%
Light	10 - 35%
Moderate	35 - 65%
Severe	65 - 100%

Estimates of current year defoliation levels were made from the egg mass sample branches. For each sampling site, the new growth on 25 randomly selected twigs

was examined in the laboratory to determine the percentage of defoliation. Defoliation estimates are based on the percent of missing needles determined by an ocular examination of each twig.

RESULTS

Arapaho National Forest: Approximately 68,191 acres were visibly damaged on National Forest and adjacent lands in 1984. The area of detectable defoliation decreased significantly from the 1983 estimate of 151,480 acres. Data from branch samples collected on the Forest indicate that the area suffered moderate to severe defoliation in 1984 and that moderate to severe defoliation can be expected again in 1985 (Table 4).

Table 4. Results of Western Spruce Budworm Egg Mass Surveys on the Arapaho National Forest in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Idaho Springs	30	40.4	17.8	Moderate to Severe
Sprucedale	30	28.0	37.9	Moderate to Severe
Summary		34.1	27.9	Moderate to Severe

Grand Mesa, Uncompahgre, and Gunnison National Forests: About 70,125 acres were moderately to severely defoliated on National Forest and adjacent lands in 1984. Similar levels of defoliation are expected in 1985. Egg mass density data is presented in Table 5.

Table 5. Results of Western Spruce Budworm Egg Mass Surveys on the Grand Mesa, Uncompahgre, and Gunnison National Forests in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Soap Creek	30	7.5	10.5	Moderate to Severe
Powderhorn	30	20.0	52.2	Moderate to Severe
Sapinero Mesa	30	11.5	38.0	Moderate to Severe
Commissary C.G.	30	9.5	28.2	Moderate to Severe
Amphitheater Campground	30	not sampled	16.7	Moderate to Severe
Summary		12.1	29.1	Moderate to Severe

Medicine Bow National Forest: About 374 acres of light to moderate defoliation were detected in 1984. No egg mass density data were collected this year.

Pike National Forest: Aerial surveys indicated that approximately 274,350 acres were infested in 1984 on the Pike National Forest and adjacent lands. This represents a 70% decline from the 1983 estimate of visible defoliation. Defoliation was moderate to severe at each of the four areas in 1984 and is expected to be moderate to severe again in 1985 (Table 6).

Table 6. Results of Western Spruce Budworm Egg Mass Surveys on the Pike National Forest in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Indian Creek	60	17.6	14.0	Moderate to Severe
Ormes Peak	30	38.3	44.8	Moderate to Severe
Little Scraggy	30	36.3	65.2	Moderate to Severe
Currant Creek	30	49.2	68.5	Moderate to Severe
Summary		35.4	48.1	Moderate to Severe

Roosevelt National Forest: Three areas were sampled. Survey results are presented in Table 7. Approximately 110,450 acres were lightly to moderately defoliated on National Forest and adjacent lands. This represents a 76% decline from the defoliated area reported in 1983.

Light defoliation is expected in 1985 at Big Elk Meadows and Devil's Gulch and moderate to severe defoliation is expected at Magnolia Road.

Table 7. Results of Western Spruce Budworm Egg Mass Surveys on the Roosevelt National Forest in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Big Elk Meadows	30	11.4	9.6	Light
Magnolia Road	60	16.5	17.6	Moderate to Severe
Devil's Gulch	30	2.5	7.0	Light
Summary		10.1	11.4	Moderate to Severe

Rio Grande National Forest: Approximately 64,066 acres were infested on National Forest and adjacent lands in 1984.

Egg mass density and defoliation data was collected in 1984 for the first time in several years. This year's data indicate that the area suffered light to moderate defoliation in 1984 and that moderate to severe defoliation can be expected in 1985 (Table 8).

Table 8. Results of Western Spruce Budworm Egg Mass Surveys on the Rio Grande National Forest in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Beaver Creek	30	not sampled	19.6	Moderate to Severe
Del Norte Peak	30	not sampled	55.3	Moderate to Severe
Embargo Creek	30	not sampled	10.7	Moderate to Severe
Summary			28.5	Moderate to Severe

San Isabel National Forest: The infested area on the San Isabel National Forest and adjacent lands increased from 139,450 acres in 1983 to 241,646 in 1984. Defoliation was light to moderate throughout the area.

Results of the egg mass survey on the San Isabel National Forest are displayed in Table 9. In 1985, moderate to severe defoliation is expected at all the sampling sites except at Alvarado Campground where only light defoliation is expected.

Table 9. Results of Western Spruce Budworm Egg Mass Surveys on the San Isabel National Forest in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Alvarado CG	30	0.3	2.1	Light
Balman Reservoir	30	26.9	19.3	Moderate to Severe
Beulah	30	1.5	24.3	Moderate to Severe
Oak Creek CG	30	4.6	23.5	Moderate to Severe
Ophir Creek	30	not sampled	16.0	Moderate to Severe
Summary		6.7	17.0	Moderate to Severe

San Juan National Forest: The area infested on the San Juan National Forest and adjacent lands increased from 865,318 acres in 1983 to 1,230,656 acres in 1984. Most of the defoliation in 1984 was moderate to severe.

This year, three new sampling sites - Halfway Canyon, Little Sand Creek and Poison Park were added to the survey in the San Juan area. The potential for moderate to severe defoliation in 1985 exists in all but four areas (Table 10). Halfway Canyon, Missionary Ridge, Pine River Campground and Wolf Creek Campground should experience only light defoliation in 1985.

Table 10. Results of Western Spruce Budworm Egg Mass Surveys on the San Juan National Forest in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Blanco Basin	30	4.7	12.1	Moderate to Severe
Cimmarrona CG	30	14.3	14.4	Moderate to Severe
Columbine Lake	30	12.9	13.1	Moderate to Severe
Coon Creek	30	2.7	12.7	Moderate to Severe
East Fork	30	25.4	31.2	Moderate to Severe
Halfway Canyon	30	not sampled	5.0	Light
Haviland Lake	30	16.5	23.6	Moderate to Severe
Little Sand Creek	30	not sampled	13.4	Moderate to Severe
Missionary Ridge	30	10.6	8.9	Light
Old Timers CG	30	14.2	13.9	Moderate to Severe
Pine River CG	30	6.9	7.3	Light
Poison Park	30	not sampled	16.2	Moderate to Severe
Transfer Park CG	30	11.0	not sampled	---
Vallecito Reservoir	30	24.4	25.5	Moderate to Severe
Wolf Creek CG	30	2.7	2.6	Light
Summary		12.2	14.3	Moderate to Severe

Shoshone National Forest: Between 1983 and 1984, the area of visible defoliation did not change on the Shoshone National Forest and adjacent lands. In 1984, approximately 133,000 acres of light to moderate defoliation were detected.

This year only three sites were sampled. Light defoliation is predicted for 1985 for the Dead Indian Creek area and Hunter Peak Campground. Moderate to severe defoliation is predicted for the Reef Creek Area (Table 11).

Table 11. Results of Western Spruce Budworm Egg Mass Surveys on the Shoshone National Forest in 1983 and 1984.

Area	Number of Branch Samples	Mean Number of New Egg Masses per Square Meter Foliage 1983	1984	1985 Defoliation Forecast
Badger Spring	30	7.4	not sampled	---
Dead Indian Creek	30	not sampled	3.5	Light
Hunter Peak CG	30	5.9	5.6	Light
Reef Creek	30	not sampled	10.8	Moderate to Severe
Rocky Ford	30	2.9	not sampled	---
Sinks Canyon	30	24.7	not sampled	---
Summary		10.2	6.6	Light

SUMMARY

Figure 2 illustrates increases and declines in detectable defoliation from 1979 to 1984 in the Rocky Mountain Region.

Between 1983 and 1984, the area of detectable defoliation in the Region declined by about 20 percent (Table 12). Significant declines occurred on the Pike, Roosevelt, and Arapaho areas where detectable defoliation decreased by 76, 70, and 54 percent respectively. Defoliation was moderate to severe in some areas of the Arapaho, Gunnison, Pike and San Juan areas and light to moderate at all the other areas. Increases in the extent of defoliation occurred on the Gunnison, Medicine Bow, Rio Grande, and San Isabel areas.

Egg mass densities increased in all areas except the Arapaho and Shoshone areas (Figure 3). The most significant increases in egg mass density occurred at the Gunnison, Pike and San Isabel areas where egg mass densities in 1984 were 29.1, 48.1 and 17.0 egg masses per square meter, respectively.

Figure 2--Western spruce budworm defoliation in Region 2, 1979-1984.

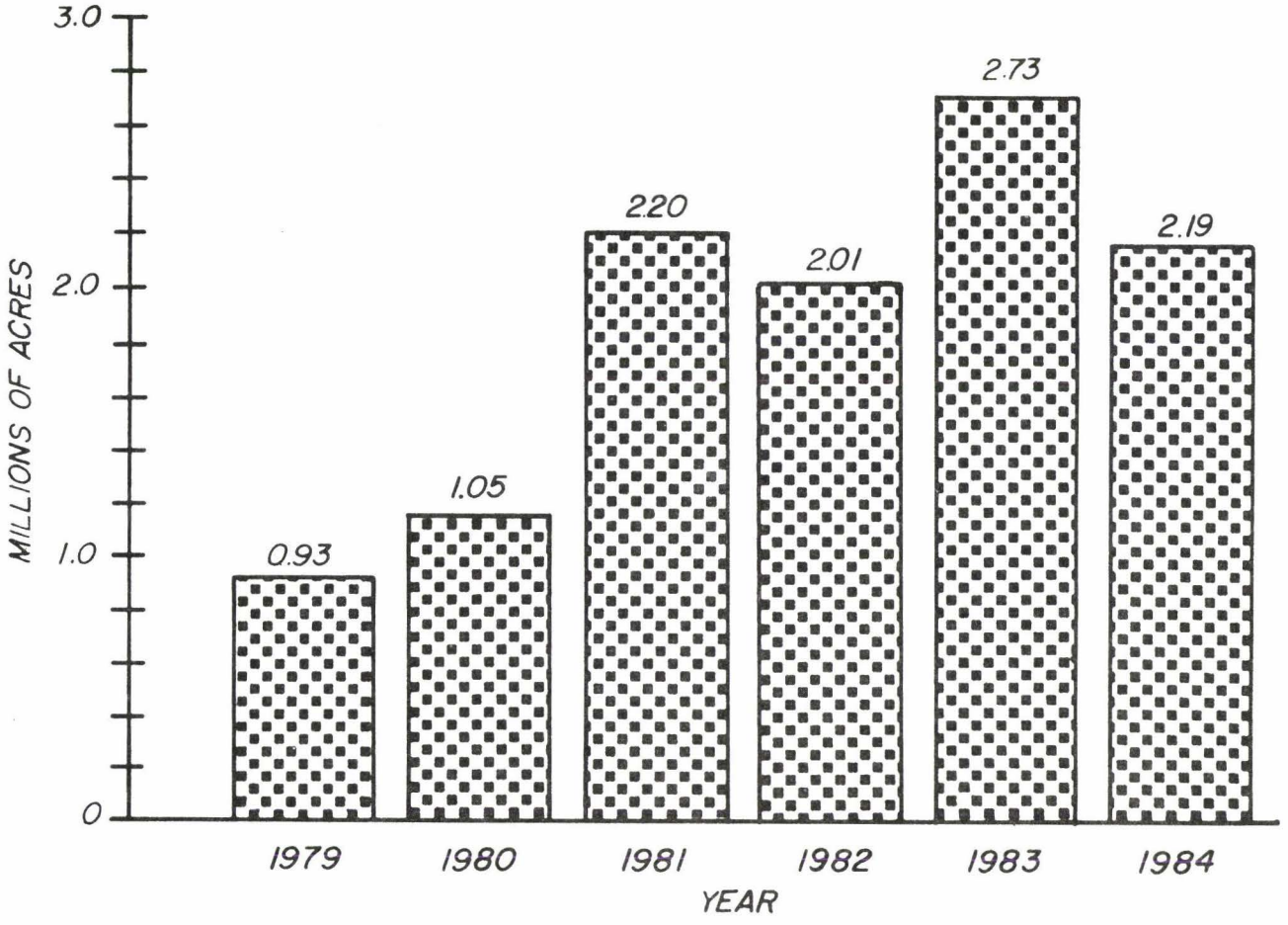

Figure 3--Results of the annual spruce budworm populatian survey from 1979 to 1984.

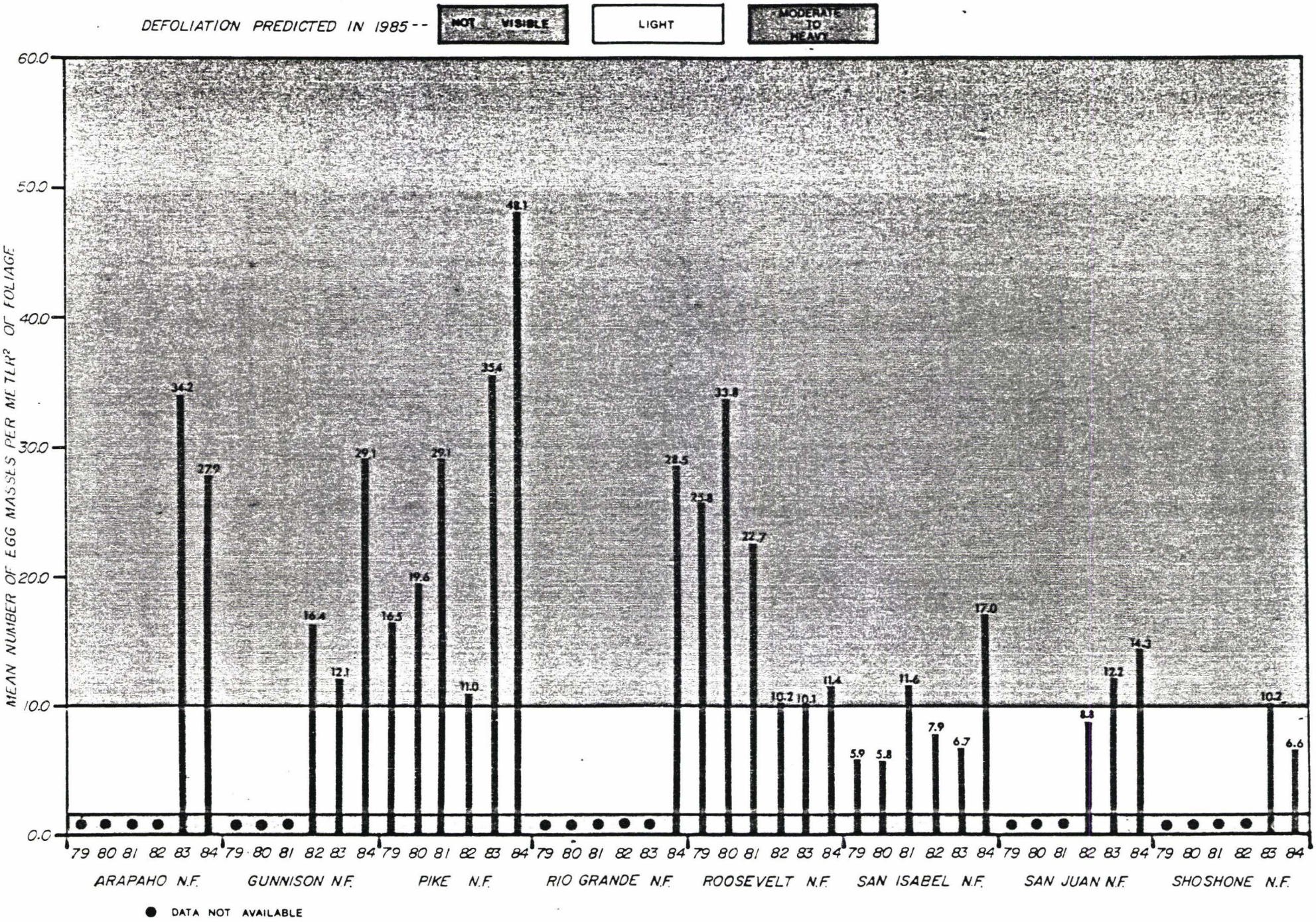

Table 12. Acres of Western Spruce Budworm Defoliation in Region 2,[1/] by Area, 1981 - 1984.

Forest	1981	1982	1983	1984
Arapaho	192,000	35,491	151,480	68,191
Gunnison	120,455	113,007	56,478	70,125
Medicine Bow	0	0	0	374
Pike	663,000	669,698	915,095	274,350
Rio Grande	0	0	20,458	64,066
Roosevelt	366,000	419,559	468,760	110,450
San Isabel	122,000	82,538	139,450	241,646
San Juan	570,000	500,834	865,318	1,230,656
Shoshone	130,000	182,054	133,372	133,000
White River	0	0	0	315
Total	2,163,455	2,003,181	2,750,411	2,193,173

[1/] Acreage defoliated by budworm was determined from aerial sketch maps made at the time of peak defoliation.

ALTERNATIVE ACTIONS

An environmental assessment (EA), prepared in 1982, presented alternative strategies for dealing with the current western spruce budworm outbreak in the Rocky Mountain Region and the environmental consequences of those strategies (USDA Forest Service, 1982). The EA identified separate sets of alternatives for undeveloped forest lands and developed forest lands (Appendix A).

The recommendations and assumptions made in the 1982 EA continue to be valid.

RECOMMENDATIONS

The following actions were recommended in the EA for undeveloped and developed forest lands (Appendix B).

A. Undeveloped Forest Lands

For undeveloped forest lands, the alternative, Maintain Current Management is recommended. Although this alternative will result in losses of esthetic and timber values, these losses are judged acceptable based on public opinion, economic evaluation, and current USDA Forest Service policies and objectives.

B. Developed Forest Lands

For developed forest lands, the alternative, Protection of Individual High Value Trees with Insecticides, is recommended because it has little environmental risk, is technically effective, and the least costly suppression strategy.

Forest Supervisors should pay particular attention to developed recreation areas where treatment may be warranted. Rationale for these recommendations are found in the 1982 EA.

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